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Report of the first session of the

WORKING PARTY ON BIOLOGICAL ACCUMULATORS of the ADVISORY COMMITTEE ON MARINE RESOURCES RESEARCH

Rome, 9-13 December 1974

with the cooperation of the
United Nations Environment Programme

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME, 1975

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

UNITED NATIONS ENVIRONMENT PROGRAMME

REPORT OF THE FIRST SESSION OF THE

ACMRR WORKING PARTY ON BIOLOGICAL ACCUMULATORS

FAO Headquarters, Rome, Italy, 9-13 December 1974

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, March 1975

PREPARATION OF THIS REPORT

This report was prepared as part of a co-operative project of the United Nations Environment Programme entitled

Effects of Pollutants on Living Aquatic Resources and Scientific Basis for Monitoring

with the Food and Agriculture Organization of the United Nations as co-operating agency.

Distribution

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REPORT OF THE FIRST SESSION OF THE ACMRR WORKING PARTY ON BIOLOGICAL ACCUMULATORS

Rome, Italy, 9-13 December 1974

1. OPENING OF THE SESSION

The first session of the ACMRR Working Party on Biological Accumulators was held at FAO Headquarters, Rome, from 9 to 13 December 1974, under the chairmanship of Dr. J.E. Portmann. Dr. Kasahara, Director, Fishery Resources and Environment Division, welcomed the members (listed in Annex III) to Rome and opened the session on 9 December.

2. ADOPTION OF THE AGENDA

The Agenda (Annex I) was adopted without changes.

3. ELECTION OF RAPPORTEUR

Dr. R.F. Addison was elected Rapporteur of the session.

4. DISCUSSION OF TERMS OF REFERENCE

The meeting opened with a general discussion of the Terms of Reference (Annex II) and their interpretation. It was generally accepted that pollutant levels in sea water might be assessed through analyses of their concentrations in "accumulator" organisms; in this context, the GESAMP definition of marine pollution was accepted, which reads:

> "Introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries), resulting in such deleterious effects as harm to living resources, hazard to human health, hindrance to marine activities, including fishing, impairing the quality for use of sea water and reduction of amenities."

It may be agreed that analyses of organisms might offer some advantages over direct analyses of sea water: these included (a) simplification of analyses through an organism's concentration of pollutants to levels often some orders of magnitude greater than those in sea water; (b) the fact that pollutant levels in an organism may have more significance than those in sea water, since the latter may not indicate concentrations which are biologically available; (c) if the accumulator organisms selected are also used as food or in the production of food stuff, their analysis would provide information relevant to food contamination, as well as to environmental monitoring. However, it was recognized that the value of accumulator organisms might change; thus the present advantages offered by their concentration of pollutants might be offset by improvements in procedures for the direct analysis of sea water. And even at present, direct analysis of sea water (or sediments) was preferable for some pollutants.

Unless calibrated by measurements of levels in water (usually necessary on a site by site basis) analysis of pollutant levels in accumulator organisms seemed capable of providing comparative, rather than absolute, information. Since accumulation of pollutants varied with several environmental factors, it might be difficult to infer a pollutant's concentration in sea water from its concentration in an organism. However, it should be possible to detect spatial differences or temporal changes in environmental quality through such analyses. Dr. Naeve pointed out that FAO was presently involved in the planning of the GFCM Coordinated Mediterranean Pollution Project including pilot projects on baseline studies and monitoring of metals and persistent organic compounds in marine organisms and that the Working Party's recommendations would be useful in that and in similar programmes.

Finally, the members felt that some riders should be attached to the Terms of Reference.

(a) Referring to paragraph ii, since no accumulator organism was likely to be distributed globally, it would be difficult to recommend a "standardized" organism although the possibility of using well-defined bacterial cultures would be discussed. However, different organisms could be used to monitor different areas, provided some overlap in range occurred - this would allow comparison of different organisms in the same environment.

(b) The terms "standardization" in paragraph iii implied specific and highly detailed analytical directions (recipes), whereas it should be recognized that analytical procedures are invariably modified to suit the particular facilities available, or the demands of a particular analytical problem: general analytical guidelines rather than specific recipes should, therefore, be provided. But, since analytical procedures would vary from laboratory to laboratory, the importance of intercalibration exercises should be stressed.

(c) Specifically paragraph iv would be interpreted as "To advise on laboratory and field studies aimed at calibrating the accumulation capacity of selected species, to be used as a sensitive tool for indirectly measuring the low concentrations in the water".

5. REVIEW OF WORKING PAPERS AND GENERAL DISCUSSION

The background papers prepared for the meeting (see list of documents, Annex IV) were then discussed, after each had been summarized by its author. The purpose of environmental monitoring was considered. It was agreed that one intention was to provide an indication of the risk of future trouble, since an increase in pollutant level in an organism, or its environment, would constitute a danger signal - even if the pollutant was not known to have any specifically detrimental biological effect. It was suggested also that monitoring implied control at some stage; this, in turn, implied that there should exist criteria of acceptable levels of pollutants, and these should be related to biological effects, such as those summarized in bioassay results, or in ecological indices. This connexion reflects the relationship of this Working Party to others dealing with bioassays and ecological indices. It was agreed that, since it was impossible to screen the entire marine ecosystem for all possible compounds, some selection had to be made: this selection would have to be based on either known or predicted biological effects. Thus, anticipation of biological effects through appropriate biological indices appeared particularly important, since only after such an effect is detected, or predicted, would it make sense to undertake a monitoring programme.

Discussion then turned to experience and problems in using accumulator organisms to detect and measure specific pollutants in the marine environment. Such monitoring programmes were already under way. Thus, routine detection of certain radio nuclides in the marine environment was based on their uptake by certain molluscs and macrophytes. Although such uptake varied with environmental factors, the concentration factors achieved (of the order of 10^3) were crucial in allowing the detection of such elements. However, since macrophytes are restricted to the euphotic zone, their application as accumulators is limited. As the accumulation of metals by macrophytes is based on their functioning essentially as ion-exchange resins, it may turn out that a non-biological ion-exchange accumulator would be more useful.

The possibility of using plankton for pollutant accumulation attracted some interest. Phytoplankton appear to reflect short-term fluctuations in organochlorine residue input to their environment, and so could be used to monitor this. This accumulation seems to be a passive adsorption process. Where accumulation involves active metabolism, as is the case with some metals, plankton are less suitable because accumulation factors vary widely with environmental conditions, and with species. Thus, natural plankton communities, whose composition and environment may differ widely, show highly variable concentrations of (presumably) accumulated metals. A particular problem in plankton analysis is that of contamination of samples by the surface film during towing: the materials analysed (especially organics) may reflect their distribution in the surface film rather than in the plankton.

Benthic invertebrates have been used successfully in environmental monitoring, for metals, organochlorines and petroleum hydrocarbons. Mytilus seemed to be most widely used, perhaps because of its ubiquity. Being sessile, its accumulation of pollutants reflected the exposure of its local environment. It was, however, noted that it may be preferable to have information about a particular body of water rather than about a point past which it flowed and, in this case, an organism associated with that body of water, e.g., a pelagic accumulator, would be required. Like other accumulators, molluscs showed varying efficiencies in accumulation in response to environmental factors, and considerable calibration work to define these factors would be desirable.

One attempt to develop a rather "standard" accumulator organism used marine bacterial cultures. However, these were not used in situ; instead, the water to be analysed had to be brought to them. This necessitated sampling and transporting 10 to 20-litre water samples, which would have therefore been available for conventional analyses; the main advantage of using bacteria to isolate pollutants from the water was that they would indicate pollutant levels which were "biologically available".

Marine vertebrates have been used to accumulate pollutants from various environments. Thus, metals, e.g., Hg, are accumulated by fish and some observed variations in tissue concentrations were consistent with expected differences in the areas from which fish had been sampled. Similarly, organochlorine levels in fish can show clear spatial or temporal variations, consistent with expected differences between the areas or periods at which the fish were sampled. Similar comparisons could be made with marine mammals and it was suggested that repeated sampling from a "tagged" marine mammal might allow fairly sensitive detection of temporal changes. A particularly interesting example involved comparison or organochlorine levels in Baltic herring sampled from different regions. Even though samples were taken from commercial catches and were not deliberately selected to minimize the possible effects of known biological factors which affect residue accumulation, clear regional and temporal differences could still be seen. As noted above, such analyses provided data useful to both environmental monitoring and food contamination surveys.

To summarize, it seemed clear that to monitor differences in environmental quality from place to place, or from time to time, is practicable, at least for some pollutants. The choice of accumulator organism and the frequency of sampling would be dictated by the kind of information required. Thus, short-term (of the order of days or weeks) fluctuations in organochlorine input to an area could be detected through phytoplankton analyses, whereas examination of longer-term trends would require a longer-lived organism. Likewise, regional differences of the order of 100-1,000 km could be detected through comparisons of fish, provided their migrations were small compared to the scale of regions being compared. The Baltic herring study mentioned above allowed comparisons of locations of the order of 100 km apart. For smaller-scale regional comparisons, sessile organisms such as fixed macrophytes, or sessile molluscs, would be preferred.

Petroleum hydrocarbons appeared to be somewhat less amenable to monitoring via biological accumulators than are, say, chlorinated hydrocarbons or metals. First, various hydrocarbons occur in natural components of various organisms. As they generally exist in very complex mixtures, more scope for selective accumulation, degradation and elimination of different pollutant compounds exists than is the case for other pollutants.

Furthermore, the petroleum hydrocarbons appear to be degraded or eliminated unchanged from various organisms relatively rapidly; concentration factors may, therefore, be lower and any accumulation might be more transient than that observed with other pollutants. Nevertheless, some correlations have been noted between hydrocarbon levels in bivalves and their environment. Specific aromatic compounds could be used as tracers for petroleum detection.

Finally, it was clear that if reliable estimates of seawater concentrations of pollutants were to be made from analysis of accumulator organisms, considerable development and calibration work must be carried out. This should include an examination of several candidate species from a range of trophic levels and laboratory studies on their capacity to accumulate, degrade and eliminate their pollutant burden.

The Chairman and Technical Secretary of the Working Party on Ecological Indices summarized their conclusions for this Working Party at the end of their meeting. Topics and problems of mutual interest were identified.

6. OUTLINE OF A FIELD MANUAL

The Working Party decided that its views and recommendations could be presented in the form of a guideline manual on the use of bioaccumulation in monitoring programmes. An outline of the contents of this was prepared (Annex V), listing the topics to be covered and the areas of responsibility of each author.

7. FURTHER WORK PROGRAMME

It was anticipated that the various sections would be completed by the members during the intersessional period and that a draft of the manual would be available to the secretariat end of April 1975.

8. DATE AND PLACE OF NEXT SESSION

It was proposed to hold the second session of the Working Party again at FAO Headquarters, Rome. The week of 14-18 July 1975 has been envisaged tentatively.

It was recommended that the second session should be devoted primarily to the finalization and adoption of the Guideline Manual.

9. ANY OTHER MATTERS

No other matters were discussed.

10. ADOPTION OF THE DRAFT REPORT

The draft report was adopted on 13 December 1974. Editorial changes were left to the secretariat.

11. CLOSING OF THE MEETING

Dr. Kasahara thanked the members of the Working Party for their constructive work and closed the session on 13 December 1974.

Annex I

AGENDA

1. Opening of the Session
2. Adoption of the Agenda
3. Election of Rapporteur
4. Discussion of Terms of Reference
5. Review of Working Papers
6. Outline of Field Manual
   (a) Ongoing Programmes
   (b) Bioaccumulator Species
   (c) Standard Working Methods
   (d) Calibration of Accumulation Capacities
   (e) Accumulation Methods in Monitoring
7. Further Work Programme
8. Date and Place of Next Session
9. Any Other Matter
10. Adoption of Draft Report
11. Closing of the Meeting

Annex II

TERMS OF REFERENCE

As a basis for using bioaccumulators in monitoring programmes to detect contaminants in the marine environment, especially at low level concentrations, taking into consideration both the methods based on the sampling of natural populations and the development of standardized, even clonal, organisms;

(i) to review on-going research and operational programmes, and present knowledge in the field of biological accumulation of contaminants;

(ii) to evaluate bioaccumulator species presently used for detection of pollutants and to advise on other organisms suitable for standardized use in monitoring programmes;

(iii) to recommend standardized working methods with emphasis on sampling and analytical techniques and experimental procedures;

(iv) to advise on laboratory and field studies aimed at calibrating the accumulation capacity of selected species, to be used as a sensitive tool for measuring low concentrations of pollutants;

(v) to develop guidelines for pilot studies aimed at introducing bioaccumulation methods into monitoring programmes.

Annex III

LIST OF PARTICIPANTS

1. List of Members of the Working Party

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Annex IV

LIST OF DOCUMENTS

ACMRR/WP-BA/1/1	Draft Agenda
2	Terms of Reference
3	List of Participants
4	List of Documents
5	Factors Affecting Organochlorine Residues Accumulation by Marine Vertebrates by R.F. ADDISON
6	Bioaccumulation and Metabolism of Organic Pollutants in the Sea by R.F. LEE
7	Primary and Secondary Producers and Transport of Contaminants in the Marine Environment by E.F. MANDELLI
8	Bioaccumulators of Radionuclides and Heavy Metals by J. PENTREATH
9	The Use of Biological Accumulators in Monitoring by D.J. REISH
10	Monitoring and Bioaccumulation by J.E. PORTMANN
11	Feasibility of Using Benthic Organisms as Indicators of Bioaccumulation by T. YOSHIDA
12	Draft Report

Annex V

DRAFT OUTLINE OF THE GUIDELINE MANUAL ON USE OF BIOACCUMULATORS

A. Introduction (J.E. PORTMANN)

1. Purpose of monitoring - i.e. in order to establish and follow the spatial and temporal variations in contaminant levels regardless of whether or not there is an initial intention or need to control.

2. Definitions - e.g. pollution, contamination, monitoring/surveillance, bioaccumulation.

3. Why use a bioaccumulator since often analytical techniques are capable of detecting extremely low levels in the aquatic medium:

   (i) Because the level in the water may be undetectable and there is a variation in what is detectable according to laboratory

   (ii) In order to be able to monitor otherwise undetectable discharge levels

   (iii) To detect unexpected contaminated areas or discharges, especially when the levels of the contaminants are too low to measure otherwise

   (iv) In order to be able to assess relative levels of contamination area by area

   (v) Because a bioaccumulator integrates water levels which may change with time

   (vi) Because, say, a bioaccumulator is more likely to reflect the biologically significant forms of a contaminant.

4. Relationship of level found to effect. There is for all contaminants a level of presence which will constitute a lethal concentration and a lower concentration which will cause a sub-lethal effect in an organism. There is equally a no-effect level, i.e. the one at which an effect is insignificant. Presence does not equal harm, although it is a danger signal.

5. Data must be intercomparable and, whenever possible, should be obtained only for a specific purpose. Mere measurement, especially on a large scale, is wasteful of time and resources.

6. Types of bioaccumulation mentioned in Lee paper (ACMRR/WP-BA/1/6). Note that in some cases bioaccumulation is a direct result of detoxification, e.g. Cd and Pb in crustaceans.

7. In the regional or international context, monitoring/surveillance is largely a matter of establishing temporal and spatial trends.

8. It does not follow that spatial trend shown by the bioaccumulator is the same as that shown by the aquatic medium. Relative distribution may differ from site to site and, for some purposes, may have no alternative but to measure water concentration as well, at intervals.

9. For a full understanding of any one environmental situation there is a need also for data on inputs; contaminant concentrations both in sediment and in water and relative concentration in other organisms, especially ultimate target organism.

10. Basic requirements of a good bioaccumulator indicator:

(i) Concentration factor relative to water generally $>10^2$

(ii) Concentration affected by minimum number of biological variables

(iii) Accumulation linear with time at least for a number of days

(iv) Numbers available readily at appropriate times and collection unaffected by public immotive interest

(v) Warning given by bioaccumulator must be adequate to allow prevention of catastrophe

(vi) Desirable to use range of organisms.

11. Bear in mind much of our knowledge has been achieved accidentally. Much information once thought extraneous now considered valuable. Full details of sample, species, age, sex, condition, size of animal and analysed organ, etc., should be recorded plus details of any sample storage, analytical methods and detection of unexpected or unidentified substances.

12. Conclusion that any monitoring programme requires <u>thought</u> and careful planning. Not merely matter of dash-out, collect and analyse.

B. <u>Monitoring Different Pollutant Classes Using Bioaccumulators</u>

I. ELEMENTS OTHER THAN RADIONUCLIDES, e.g. MERCURY, CADMIUM, COPPER, ZINC, LEAD AND ARSENIC (E. MANDELLI)

1. <u>Inputs: Sources and Routes of Entry</u>

(i) Man-made) via air, rivers, discharges,
(ii) Natural) dumping and dredgings
(iii) Physical distribution in the environment
(iv) Chemical speciation in the environment

2. <u>Analytical Procedures</u>

(i) Sampling methods
(ii) Sample size and storage
(iii) Analytical techniques including preparation

3. <u>Biological Transfer and Transformation Process Distribution</u>

(i) Summary of data by metal and organism
(ii) Laboratory uptake and loss experiments
(iii) Field surveys
(iv) Biological transfer
(v) Biological transformations

4. Criteria for Selection of Species and Communities

(i) Availability, i.e. suitable numbers available at appropriate times and sites
(ii) Ecological importance
(iii) Commercial value
(iv) Pure bioaccumulation capacity but of no known ecological or commercial importance

5. Reporting of Results

(i) Data coding to be adopted (i.e. standardized format)
(ii) Evaluation of results.

II. RADIONUCLIDES (J. PENTREATH)

1. Input Sources

Air, rivers, discharges

Note that there are natural sources of radioactivity and radioactive substances present naturally in the marine environment.

2. Analytical Methods

Brief mention of counting techniques, and spectrometry, and preparation of samples.

3. Uptake and Loss Studies

(i) Laboratory. Relative importance food versus water

(ii) Field studies including need to balance desirability versus practicality

(iii) Variation in uptake characteristics according to speciation of radionuclide, seasonal and other factors

4. Selection of Species

(i) Critical Path analysis

(ii) Algae

(iii) Molluscs

(iv) Fish

5. Reporting of Results

Assessment, need to repeat observations, scale and detail.

III. PETROLEUM HYDROCARBONS (R.F. LEE)

1. Inputs: Sources and Routes of Entry

2. Analytical Methods

3. Biological Transfer and Transformation Processes - Distribution

(i) Uptake information

Oil spill studies
Chronic low level oil in polluted areas
Benzpyrene studies
Uptake from water and/or food - laboratory studies

(ii) The relationship of hydrocarbons in organisms to the concentration in the environment

Field and laboratory information concerned with the relationship of hydrocarbon concentrations in the organisms to that in the water

Biomagnification

(iii) Biogenic versus petroleum hydrocarbons - focus on aromatic hydrocarbons

(iv) Metabolism of hydrocarbons

Induction of hydroxylating enzymes
Different rates of metabolism for aromatic and paraffinic hydrocarbons

(v) Storage by certain tissues

(vi) Basic problem of relating analytical studies to bioaccumulation from water and/or food

Analytical studies give no information on method of uptake
Need laboratory studies on uptake, metabolism, storage and discharge correlated with analytical studies on field samples

(vii) Rôle of sediments in hydrocarbon transfer to organism.

4. Selection of Species

(i) Bivalves

Lack of hydrocarbon metabolism
Bioaccumulation of hydrocarbons
Knowledge of their biology and physiology
Ability to be maintained under laboratory conditions
Ability to live in oil-polluted areas
Large size allowing dissection of different tissues

(ii) Other species.

IV. PCBs, DDT AND OTHER CHLORINATED PESTICIDES (R.F. ADDISON, S. JENSEN)

1. Introduction: brief

2. Inputs: Sources and Routes of Entry

(i) Use as industrial compounds and pesticides from 1930 on

(ii) Physical distribution mostly absorbed.

(Note that in (i) and in all subsequent sections there are variations in behaviour from group to group, but a common distribution and behaviour based on lipophilicity.)

3. Analytical Procedures

4. Distribution

(i) Uptake (by group and organism)

(ii) Elimination (by group and organism)

(iii) Storage concentrations affected by: (a) age
(b) sex
(c) nutritional status

(iv) Metabolism (by group and organism)

(v) Interactions among group members.

5. Species Selection

(i) Relation to aims of programme

(ii) Accessibility.

V. MISCELLANEOUS SUBSTANCES (S. JENSEN, R.F. ADDISON)

1. Literature Study

This should review:

(a) Substances already known to be accumulated in organisms and detected in environmental samples (examples to be given)

(b) Substances known to be released to the environment and belonging to the same chemical classes as in 1(a) but not yet found in nature

A note to be included that certain substances are known to affect the accumulation rate of other substances (e.g. ABS).

2. Laboratory Experiments

Under conditions close to the natural ones (salinity, temperature, etc.) estimate:

(a) Accumulation factors or rate; a note to be included that it will also be necessary to establish biological effects (lethal or sub-lethal).

(b) Elimination factors and mechanisms

(If possible, elimination should be separable into metabolised and non-metabolised fractions.)

3. Selection of Substances to be Investigated

(a) In the area to be monitored, a pilot study should tell if a primarily selected substance is present at all, using the highest degree of analytical sensitivity

(b) When the presence of a substance has been confirmed then try to select one or more accumulator organisms having the highest accumulation efficiency.

4. Recommend one or more analytical methods for each substance. These methods should be both selective and sensitive.

5. Find ways to report the presence of substance not taken into consideration in the selection of substances to be dealt with in the monitoring programme.

6. Unprejudiced research using general methods for separating the substances into chemical classes.

7. A general note on the fact that groups of chemicals might, on the basis of past experience, be considered likely to be accumulated.

C. A Matrix Table (to be developed at second session)

This would be included as a quick summary of the data given in detail under section B of the manual. By this means it would be possible to indicate wherever a particular type of bioaccumulator is suitable for monitoring a contaminant. An entry to this effect would be made in the appropriate box in the table. It would generally, although not always, be possible to show whether the relationship between water concentration and that in the organism was constant, regardless of site of collection or biological factors. It would also be possible to indicate whether the organism concerned was most appropriate for detection of a contaminant at a single site, at several sites (i.e., spatial variations) or to reveal temporal changes at one or a number of sites. Whenever it is known that there is no need to select an organism according to age, size, sex, condition, etc., an appropriate entry would also be given.

An outline of the Matrix Table is attached and a draft key (not in final form) is given below:

	Organochlorine Pesticides and PCBs	Petroleum Hydrocarbons	Metals/Metalloids	Radionuclides
			Hg, Cd, Pb, Zn, Cu, As	Co, Fe, Mn, Cs, Ce, Ru, Zr/Nb
Plankton				
Phytoplankton				
Zooplankton				
Macrophytes				
Red				
Green				
Brown				
Molluscs, benthic				
Bivalves				
Gastropods				
Crustaceans, benthic				
Whole				
Exo Skeleton				
Digestive Tract				
Polychaetes				
Fish				
Pelagic Muscle				
Pelagic Liver				
Demersal Muscle				
Demersal Liver				
Marine Mammals				
Blubber				
Liver				
Muscle				
Brain				

Key

Suitable	Yes	X
	No	O
Constant relationship to water level, regardless of site		CS
Constant relationship to water level, regardless of biological factor		CB
Suitable for single site		I
Suitable for several sites		N
Reveals temporal variations		T
No need to select according to Age/Size		A
No need to select according to Sex		M/F
No need to select according to Condition		Cond.

Thus an example of an ideal entry would be:

X CS CB N T A M/F Cond.

i.e., organism is suitable, constant relation water to organism concentration regardless of site or biological factors, can be used to reveal spatial trends with time and there is no need to select the organism according to age/size, sex or condition.

D. Proposed Pilot Study in Monitoring (D.J. REISH)

I. PREPARATIONAL PHASE

(a) Literature review

1. Pilot study area
2. Important worldwide studies
3. Summarize pertinent data by pollutant, organism and geographical area

(b) Assemble research capabilities of pilot study area

1. Personnel
2. Laboratories
3. Ships
4. Training and education

(c) Summarize input sources, types and amounts of contaminants of pollutants

(d) Selection of pollutants to be monitored

(e) Selection of species to be monitored

1. Criteria for selection

(i) Food chain
(ii) Ecological niche
(iii) Wide distribution
(iv) Availability
(v) Commercial importance

2. Assemble known distributional data of species
3. Assemble existing knowledge on the biology of selected species

(f) Intercalibration

(g) Sampling procedures

1. Location - to be established in light of site visits
2. Frequency

(h) Coordination of participating laboratories

II. SCREENING PHASE

(a) Laboratory studies - uptake of pollutants

1. Species
2. Pollutants

(b) Field studies - testing of procedures

(c) Evaluation

1. Species
2. Pollutants
3. Number of organisms in a sample

III. OPERATIONAL PHASE - PILOT PROGRAMME

(a) Data

1. Collection
2. Evaluation

(b) Coordination

(c) Emergency procedures

IV. SYNTHESIS AND EVALUATION OF PILOT PROGRAMME INCLUDING PUBLICATION OF DATA

E. Analytical Methods (T. YOSHIDA)

1. Brief outline of essential instrumentation per pollutant class and what it is capable of analysing in terms of samples/week.

2. Whether preparation is necessary and perhaps a brief outline of sort of procedure which would be followed, e.g.,dissolve in acid extract or not direct application to instrument.

3. Size of sample likely to be needed and brief outline of basic preparation for the analyst, e.g., should it be wrapped in foil or placed in a glass jar or polythene bag, can it be preserved in e.g.,Formalin or deep freeze or both. If to be dissected prior to sending to laboratory, basic precautions.

4. Source of variability in analytical results due to analyses procedures/errors. In one laboratory and between a number of laboratories.

5. On an international/regional scale the need for training of personnel, intercalibration and source of suitable reference standard materials.

6. Need or otherwise to adopt the same method, i.e. precise details, or merely guidelines as to methods which have been found suitable for particular pollutants and need to report unexpected or unidentifiable contaminants.

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